

## METHOD AND APPARATUS FOR PROVIDING SUBIMAGES TO REMOTE SITES

### 1    **Field of the Invention**

2            The present invention relates to providing images to remote sites. More  
3 particularly, the present invention relates to a method of and an apparatus for providing  
4 differing subimages of a sensed image to remote sites.

### 5    **Background**

6            Transmission of images to remote sites is known. One application for  
7 transmitting images to remote sites is a security system, in which one or more cameras  
8 are connected to a central station for monitoring.

9            Conventional security systems typically employ one or more cameras pointed at a  
10 particular field of interest, with a plurality of monitors in the central station being used to  
11 view the images from the cameras. The cameras are mounted on pan and tilt  
12 mechanisms, which allow security personnel to change the field of view of the cameras  
13 in order to view a particular field of interest.

14           While conventional security systems are useful in observing a desired field of  
15 interest, they require mechanical pan and tilt mechanisms to change the field of view of  
16 the cameras. In addition, if multiple personnel are viewing an image from a camera, only  
17 one person can control the field of view to be observed.

18           Another conventional method for transmitting images to remote sites is utilized in  
19 web-based applications. In the conventional method, persons accessing an image  
20 database or a live feed from a remote web server download images from the remote web  
21 server.

22           Web-based applications that operate in the above manner are inefficient in that a  
23 user at a remote site may only be interested in a portion of the image generally available  
24 from the web server, while the entire image is transmitted to the user. The transmission  
25 resources of the data path between the remote site and the web server are therefore  
26 wasted by transmitting image data that the user has no desire to view.

1           Therefore, a need exists for a method of providing images to remote sites that  
2 allows users at remote sites to independently view desired images, without wasting  
3 transmission resources.

#### 4       **Summary of the Invention**

5           The present invention overcomes the shortcomings of the conventional art and  
6 may achieve other advantages not contemplated by the conventional art.

7           According to a first aspect of the invention, an image access system includes an  
8 image sensor for sensing an image, and an image processing system operably coupled to  
9 the image sensor for receiving image data from the image sensor, and for generating and  
10 transmitting portions of the sensed image to remote sites. The portions of the sensed  
11 image are referred to as a "subimages" of the sensed image. The subimages are selected  
12 by users at the remotes sites.

13           According to a second aspect of the invention, a method of providing subimages  
14 to remote sites includes sensing an image of a scene, establishing a connection with  
15 remote sites, transmitting the sensed image to the remote sites, receiving selections of  
16 subimages of the sensed image to be viewed by the users at the remote sites, and  
17 transmitting the subimages to the remote sites.

18           According to the above aspects of the invention, an image access system can  
19 sense an image from a field of interest, and remote sites can access the image access  
20 system to view selected subimages from the sensed image. Further, because the users at  
21 the remote sites electronically select subimages from the sensed image, the image sensor  
22 does not need to be movably mounted to scan the field of interest.

23           As a further advantage, each remote site can select a subimage from the sensed  
24 image independent from the other remote sites.

25           A still further advantage results from transmitting selected subimages to remote  
26 sites, rather than the entire sensed image. Transmitting only the portion of the sensed  
27 image of interest to the user at the remote site conserves data path resources between the  
28 remote site and the image access system.

29           Other aspects and advantages of embodiments of the invention will be discussed  
30 with reference to the figures and to the detailed description of preferred embodiments.

1     **Brief Description of the Figures**

2             Fig. 1 is a schematic view of an image access system according to an  
3     embodiment of the invention.

4             Fig. 2 illustrates selection of subimages from a sensed image.

5             Fig. 3 is a schematic view of a sensor control according to an embodiment of the  
6     present invention.

7             Fig. 4 is a flow chart illustrating a method of providing subimages to remote sites  
8     according to an embodiment of the invention.

9             Fig. 5 is a flow chart illustrating generation of subimages.

10    **Detailed Description**

11            An apparatus and a method for providing subimages to remote sites according to  
12    the present invention will be described below by way of preferred embodiments and with  
13    reference to the accompanying drawings.

14            Fig. 1 is a schematic view of an image access system 10 according to an  
15    embodiment of the invention. The image access system 10 comprises optics 12, an  
16    image sensor 14 disposed to sense images from a scene 5 through the optics 12, an image  
17    processing system 16 for generating and transmitting subimages using image data from  
18    the image sensor 14, and an input/output (I/O) device 26.

19            The image processing system 16 includes an access control 24 that performs  
20    general management functions for the image access device 10. The access control 24 is  
21    coupled to the I/O device 26 to receive requests from remote sites 40, and is coupled to a  
22    sensor control 18, a frame buffer 20, and a processor 22, to control the transmission of  
23    images to the remote sites 40. The I/O device 26 is coupled to the remote sites 40  
24    through a connection medium 30. The sensor control 18 is coupled to the image sensor  
25    14 for receiving image data, and coupled to the frame buffer 20 to transmit selected  
26    images to the frame buffer 20. The frame buffer 20 is coupled to the processor 22 to  
27    transmit images to the processor 22 for formatting before transmission to the I/O device  
28    26.

29            The general functions of the elements of the image access device 10 will be  
30    discussed below with reference to Figs. 1 and 2. A remote site 40 establishes a  
31    connection with the image access system 10 through the I/O device 26. The I/O device  
32    26 transmits the request for connection to the access control 24, where the access control

1 24 determines characteristics of the remote site 40. The access control 24 instructs the  
2 sensor control 18 to provide an image of the scene 5 sensed by the image sensor 14 to the  
3 remote site 40. The sensor control 18 transmits the sensed image to the frame buffer 20,  
4 and the sensed image is then transmitted to the processor 22 for formatting. The  
5 formatted sensed image is transmitted to the remote site 40 via the I/O device 26 and the  
6 connection medium 30, and the remote site 40 displays the sensed image 50 (Fig. 2).  
7 The user at the remote site 40 selects a subimage 52 of the sensed image 50, and  
8 transmits a request to view the subimage 52 to the access control 24 via the connection  
9 medium 30 and the I/O device 26. The access control 24 instructs the sensor control 18  
10 to obtain the image data of the subimage, and to transmit it to the remote site 40, where  
11 the subimage 52 is displayed.

12 Referring to Fig. 2, a user at a remote site 40 can select the subimage 52 from the  
13 sensed image 50, while another user at another remote site 40 can select a subimage 54,  
14 56, or any other subimage, from the sensed image 50. Any subimage may be transmitted  
15 to one or more of the remote sites 40. For the purposes of this specification, the term  
16 "subimage" is intended to indicate a particular portion of a sensed image, rather than a  
17 single, static frame of an image. Both the sensed image and subimages may be  
18 transmitted to remote sites as a series of frames. Once the user has chosen a subimage  
19 from the sensed image 50, the image access device 10 may provide updated, or  
20 refreshed, frames of the subimage, as the image sensor 14 senses sequential frames of the  
21 sensed image 50. A user at a remote site 40 can therefore view a sensed image or a  
22 subimage in real time. While viewing, for example, the subimage 52, the user can also  
23 select a new subimage 54, 56, or any other subimage, from the sensed image 50.

24 In Fig. 1, three remote sites 40 are shown for illustrative purposes, and it is within  
25 the scope of the invention for the image access system 10 to provide subimages to any  
26 number of remote sites 40. A remote site 40 can be any site capable of displaying image  
27 data and capable of transmitting data over the connection medium 30.

28 According to the embodiment illustrated by Fig. 1, the image sensor 14 may  
29 include a relatively high resolution, wide field of view sensor array. In general, the  
30 image sensor 14 may be directed towards a field of view containing the scene 5 to be  
31 observed. By accessing the image access system 10, users at the remote sites 40 can  
32 either view a sensed image of the entire scene 5, or they may view subimages of the

1 sensed image. A wide field of view sensor 14 is particularly desirable in applications  
2 such as, for example, an area security system, where a large area must be monitored.  
3 Other applications, such as monitoring large outdoor events (parades, etc.), classrooms,  
4 or similar environments, may also require a wide field of view sensor. In general, the  
5 field of view of the image sensor 14 can be tailored to accommodate the activity or area  
6 to be monitored.

7 Because the image sensor 14 may be of relatively high resolution, users at the  
8 remote sites 40 can observe a wide field of view, and can select subimages from the  
9 sensed image that are of satisfactory resolution. A further advantage is that by observing  
10 a wide field of view, there is no need for mechanical steering servomechanisms to steer  
11 the image sensor 14. Instead, a user at a remote site 40 can pan and zoom electronically  
12 through the sensed image, and select a desired subimage without mechanical movement  
13 of the image sensor 14.

14 The image sensor 14 may alternatively have a relatively small field of view. A  
15 small field of view may be desirable for observing, for example, medical procedures,  
16 astronomical images, presentations of data, and other activities or regions where the field  
17 of interest is relatively small. In these types of applications, the field of view of the  
18 image sensor 14 may be tailored to the size of the activity observed, and the resolution of  
19 the image sensor 14 may also be tailored so that a desired degree of resolution may be  
20 obtained for subimages transmitted to the remote sites 40.

21 The image sensor 14 can comprise any sensor array capable of receiving energy  
22 reflected from or emitted by an image 5. For example, the image sensor could be an  
23 optical sensor, such as a charge coupled device (CCD), or a CMOS imaging array, and  
24 may, for example, be incorporated into a camera. For some applications, such as in a  
25 telescope used for astronomical observation, the image sensor 14 could be a radio  
26 frequency or ultraviolet sensor array. An infrared sensor may also be used for  
27 applications such as security devices, where night vision may be required.

28 The resolution of the image sensor 14 is dependent upon the degree of resolution  
29 required by the users at the remote sites 40. For example, for viewing a surgical  
30 procedure, it may be desirable to use a CCD camera having a relatively narrow field of  
31 view, which may be, for example, between 1 and 20 degrees, and having a CCD sensor  
32 array with a resolution of between, for example, 10,000 and 100,000 pixels per inch.

1 It may also be desirable to utilize a high resolution image sensor 14 to observe a  
2 large field of view. This application may be required for monitoring outdoor events or  
3 other large gatherings in which it may be necessary to focus on specific locations,  
4 objects, or persons. If a sufficiently large field of view is to be monitored, the image  
5 sensor 14 can be constructed of a plurality of sensor arrays arranged in a tiled fashion so  
6 as to constitute a single image sensor 14. The image data from the individual arrays may  
7 be formatted as a single sensed image at the sensor control 18. If an array of tiled sensor  
8 arrays is used to form the image sensor 14, the natural demarcations between the tiled  
9 arrays can be presented to the users at the remote sites 40 as a dividing line between  
10 predetermined subimages. Alternatively, users may be allowed to select any desired  
11 subimage from the sensed image.

12 In applications such as the use of the image access system 10 in conjunction with  
13 a telescope for astronomical observation, the field of view for the image sensor 14 may  
14 be relatively narrow, on the order of, for example, 1 to 30 seconds of arc. It would also  
15 be desirable to use a relatively high resolution sensor array in the image sensor 14, which  
16 may be on the order of, for example, between 10,000 and 100,000 pixels per inch. The  
17 field of view of the image sensor 14, as modified by the optics 12, is selected such that  
18 the image sensor 14 does not require mechanical steering in order to observe a region of  
19 interest, while allowing users at remote sites 40 to observe subimages within the field of  
20 view.

21 The image sensor 14 can include a controller for an iris for the image sensor's  
22 sensor array, a focus and aperture control, control functions for scanning rate, active gain  
23 control, and refresh rate, and other standard array control functions.

24 The optics 12 may be any lens arrangement suitable for modifying images.  
25 Examples of lens arrangements providing a wide field of view include wide angle lenses,  
26 and fish eye lenses. If the optics 12 includes a "fish eye", or some other wide field of  
27 view lens utilizing distortion, a wider field of view can be observed by the image sensor  
28 14. A distortion compensation algorithm or a correction table may be applied to the  
29 image data of the sensed image to compensate for distortion from a lens with distortion.  
30 If a wide field of view lens is utilized in the optics 12, it is preferable to increase the  
31 resolution of the image sensor 14, so that users at the remote sites 40 have access to  
32 subimages of sufficient resolution.

1           The sensor control 18 is coupled to the image sensor 14 to receive image data of  
2 a sensed image from the image sensor 14, and to provide image data of either a sensed  
3 image or a subimage to the processor 22. The sensor control 18 may be, for example, a  
4 control processor utilizing routines such as array access and control routines. The image  
5 sensor 14 transmits the sensed image to the sensor control 18 in, for example, analog  
6 format. The sensor control 18 can include, for example, a graphics processing system,  
7 for converting the image data from the image sensor 14 into, for example, byte serial  
8 digit format, for transmission to the processor 22. The sensor control 18 is responsive to  
9 the access control 24 to obtain data for either a sensed image or a selected subimage for  
10 transmission to the processor 22, and for eventual transmission to a remote site 40 on a  
11 channel assigned to the remote site 40. The sensor control 18 is illustrated in further  
12 detail in Fig. 3.

13           Fig. 3 is a schematic view of the sensor control 18. The sensor control 18  
14 comprises a buffer 32 for storing image data from the image sensor 14, and an image  
15 data allocator 34 for allocating image data to channels 1-n. The sensor control 18 is  
16 responsive to requests for specific subimages, and other requests, from the remote sites  
17 40, as communicated by the access control 24.

18           The buffer 32 can include at least n parallel buffers, a buffer corresponding to  
19 each of the n channels for communicating images to the remote sites 40. Therefore,  
20 when the user at a remote site 40 requests to view a subimage, the access control 24  
21 transmits the request to the sensor control 18, the sensor control 18 selects the image data  
22 (or, more specifically, "subimage data") corresponding to the subimage from one of the n  
23 buffers, and transmits it to the frame buffer 20 via a channel assigned to the remote site  
24 40. The access control 24 interprets the user's request for a particular subimage as a  
25 location of the sensed image, and transmits this location to the sensor control 18. The  
26 location describing the subimage may be described in terms of, for example, row and  
27 column values on the image sensor 14. The sensor control 18 can select the appropriate  
28 data using, for example, a block of pixels between two pairs of diagonally opposed  
29 coordinates.

30           Alternatively, the buffer 32 can include a buffer having multiple ports, from  
31 which the image data allocator 34 can draw the subimage data of requested subimages,

1 and transmit each subimage on its appropriate channel to the frame buffer 20, for  
2 eventual transmission to the requesting remote sites 40.

3 The characteristics of the n channels, which can be described in terms of, for  
4 example, bandwidth, update rate, and image optimization characteristics such as real  
5 time capability, high resolution capability, update rate, and color depth, may vary.  
6 Channels may be configured to allow multiple remote sites 40 to be assigned to one  
7 channel, by, for example, multiplexing. The access control 24 may assign multiple  
8 remote sites 40 to a single channel if the transmission requirements for the remote sites  
9 40 can be accommodated by the channel.

10 The access control 24 is responsible for receiving requests from the remote sites  
11 40, determining whether the remote sites 40 are authorized to access the image access  
12 system 10, assigning priority levels to the remote sites 40, assigning channels to the  
13 remote sites 40, and performing other management functions such as determining a level  
14 of exclusivity of the remote sites 40. The access control 24 can include, for example,  
15 access and security verification and control routines. The access control 24 may include  
16 one or more input ports that are coupled to the I/O device 26, to receive communications  
17 from the remote sites 40.

18 The access control 24 can include one or more authorization routines, such as  
19 password or biometric verification. When a remote site 40 accesses the image access  
20 system 10 through the connection medium 30, the user at the remote site 40 may be  
21 asked to provide a user ID, an access code, or other identifying data, before being  
22 provided access to the sensed image or other options available from the image access  
23 system 10.

24 The access control 24 may also include one or more priority routines. Using the  
25 priority routines, the access control 24 can allocate resources of the image access system  
26 10 according to a level of priority assigned to a particular remote site 40. For example,  
27 the image access system 10 may be provided to certain users at remote sites 40 for a fee,  
28 and the fee may vary according to a desired level of service. Alternatively, certain users,  
29 such as government agencies, may be afforded a high priority level based upon, for  
30 example, emergency status, national security, and other factors affecting the public  
31 interest. The priority routines allow the access control 24 to assign resources, such as



1 preference in being assigned a channel, channel bandwidth, refresh rate, and other  
2 variables, according to the priority level of the remote site 40.

3 The image access system 10 can transmit subimages on a finite number of  
4 channels. Therefore, during periods of particularly high demand, certain remote sites 40  
5 may be denied access to a desired subimage because a channel is not available for use.  
6 Alternatively, the remote site 40 may be given the option to view a subimage currently  
7 being viewed at another remote site 40 that has been assigned a channel. A remote site  
8 40 may elect to "share" another remote site's image data if, for example, the subimage  
9 transmitted to the other remote site 40 is of interest to the user at the remote site 40 that  
10 was denied a channel assignment. If a user at a remote site 40 does not wish for another  
11 user to view his subimage selection, the user may request of the access control 24 that  
12 her assigned channel not be shared with other remote sites 40. This "exclusivity" option  
13 can be available based upon, for example, priority level, or, exclusivity may be made  
14 generally available to all remote sites 40.

15 A user at a remote site 40 may also elect to specifically identify his subimage  
16 selection by his user ID, by name, or by some other identifying indicia. This feature  
17 would allow other users, such as students, to view the subimages selected by the  
18 identified user. To facilitate viewing of an identified user's subimages, the access  
19 control 24 can provide a prompt or a menu allowing users at remote sites 40 to select  
20 among identified users.

21 Depending upon the nature of the sensed image, the access control 24 can also  
22 restrict certain remote sites 40 to certain regions of the sensed image, and may allow the  
23 remote sites 40 to view subimages only from authorized portions of the sensed image.

24 The frame buffer 20 temporarily stores subimages transmitted on the n channels  
25 for eventual transmission to the processor 22. The frame buffer 20 can comprise a  
26 plurality of parallel buffers, each buffer being assigned to a particular channel.  
27 Alternatively, the frame buffer 20 can be one or more buffers, with the frame buffer 20  
28 having at least n ports for transmitting subimages on the n channels. The access control  
29 24 is coupled to the frame buffer 20 to control the transmission of subimages to the  
30 processor 22. The frame buffer 20 may also perform some formatting of subimages,  
31 such as scaling and normalization.

1           The processor 22 receives subimages from the frame buffer 20 and formats them  
2 for transmission to the remote sites 40 via the I/O device 26 and the connection medium  
3 30. The processor 22 may have MPEG encoding functionality for scaling, compressing,  
4 and performing other tasks on the subimages so that they are suitable for use by the  
5 remote sites 40. After formatting the subimages, the processor 22 transmits the  
6 subimages to the I/O device 26, where the subimages are subsequently transmitted to the  
7 connection medium 30.

8           The elements comprising the image processing system 16 are all illustrated as  
9 individual elements for the purposes of illustration. However, one or more of these  
10 elements can comprise routines or instructions stored on and executable by, for example,  
11 a central processing unit or units of the image processing system 16. The terms  
12 “transmit,” “transmission,” and variations thereof, are used broadly in this specification  
13 to generally describe the passage of data, and are not specifically intended to require the  
14 passage of data through a cable, the airwaves, or any other specific medium.

15           The image access system 10 is adapted to transmit images through a variety of  
16 connection media. For example, the connection medium 30 may be the Internet, an  
17 intranet, a direct cable connection, a satellite network, or other media for connecting  
18 remote sites.

19           A method of providing images using the image access system 10 will now be  
20 discussed with reference to Figs. 4 and 5. In the discussion below, the method describes  
21 providing images to a single remote site 40. It is to be understood that the image access  
22 system 10 can simultaneously provide images to a plurality of remote sites 40.

23           In Step S8, the image access system 10 senses an image of the scene 5 using the  
24 image sensor 14. The sensed image can be a static image, or, it may constitute a series of  
25 frames of the scene. As long as the image access system 10 is operating, the image  
26 sensor 14 can substantially continuously sense images from the scene 5.

27           In step S10, a remote site 40 transmits a request to connect to the image access  
28 system 10 via the connection medium 30. If the connection medium 30 is the Internet,  
29 the request may be transmitted by, for example, entering a universal resource locator  
30 (URL) address for the image access system 10. The I/O device 26 transmits the remote  
31 site 40 request to the access control 24, and the access control 24 determines whether the  
32 remote site 40 is authorized to access the image access system 10 in step S12. The

1 access control 24 can establish remote site authorization by, for example, requesting a  
2 user name and/or password from the remote site 40.

3 If the remote site 40 cannot provide a proper user name and/or password, the  
4 access control 24 notifies the remote site 40 that its attempt to access has failed in step  
5 S14. At this time, the access control 24 can terminate the connection with the remote  
6 site 40. Alternatively, the access control 24 can prompt the remote site 40 to reenter its  
7 user name and/or password.

8 If the access control 24 determines that the remote site is authorized to access the  
9 image access system 10, the access control 24 determines the remote site 40  
10 characteristics in step S16. The characteristics of the remote site 40 can include, for  
11 example, priority level, exclusivity level, a preference for certain channel characteristics,  
12 a preference for certain transmission characteristics, and the preference to have the  
13 subimages associated with the user's name or user ID. The characteristics can be  
14 requested of the remote site 40 by the access control 24, or, they may have been provided  
15 on a previous access, and may be stored within the access control 24.

16 When the access control 24 has determined the characteristics of the remote site  
17 40, the access control 24 instructs the processor 22 to transmit the sensed image to the  
18 remote site 40 in step S18. The remote site displays the sensed image in step S20. The  
19 sensed image transmitted to the remote site 40 can have many forms. For example, the  
20 sensed image may be the entire image sensed by the image sensor 14. The sensed image  
21 could also be the entire image sensed by the image sensor 14, minus any restricted areas  
22 that the remote site 40 is not authorized to view.

23 The sensed image could also be a symbolic representation of the field of view  
24 that the image sensor 14 senses. For example, if the image sensor were used in an  
25 astronomical observatory, the sensed image may represent quadrants of a telescope's  
26 field of view. Transmitting a symbolic representation of the image sensor 14 field of  
27 view may enable the user at the remote site 40 to more quickly identify the subimage that  
28 the user wishes to view. In addition, a symbolic representation of the sensed image may  
29 require less data path resources to transmit over the connection medium 30.

30 The sensed image may be made generally available to all authorized remote sites  
31 40 via the processor 22, prior to assigning channels to the remote sites 40. Therefore,  
32 channels within the image access system 10 are not wasted on remote sites 40 that

1 choose not to select a subimage from the sensed image. In that case, the user at the  
2 remote site 40 can simply disconnect from the image access system 10.

3 In step S22, the user at the remote site 40 selects a subimage from the sensed  
4 image, and transmits the selection to the access control 24. When selecting a subimage  
5 of the sensed image, the user at the remote site 40 can select from, for example,  
6 predetermined quadrants or sectors of the sensed image. The user at the remote site 40  
7 can alternatively select a portion of the sensed image using, for example, a mouse, a  
8 keyboard, and electronic pen devices interacting with sensitive viewing screens. In  
9 selecting a subimage, the user can pan across the sensed image, and may zoom in on a  
10 particular portion of the sensed image before selecting a subimage.

11 Depending upon the priority level of the remote site 40, the user may also change  
12 the transmission characteristics of the subimage to be transmitted during the selection of  
13 a subimage. For example, upon viewing the sensed image, the user at the remote site 40  
14 may decide to change the resolution, update rate, real time capability, the pixel rate, color  
15 depth, or other transmission characteristics of the subimage, based upon the particular  
16 image that he wishes to view.

17 In step S24, the access control 24 determines whether a channel is available to  
18 transmit the selected subimage to the remote site 40. If a channel is available, the access  
19 control 24 assigns a channel to the remote site in step S26. As an alternative to assigning  
20 a channel to the remote site 40 after selecting a subimage, the remote site 40 may be  
21 assigned a channel upon connecting with the image access system 10.

22 Each remote site 40 may be assigned to a single channel, or depending upon the  
23 channel characteristics, one or more remote sites 40 may be multiplexed to a single  
24 channel. The plurality of channels are preferably configured so that they are able to  
25 convey image data of the sensed image, and subimages, having a desired resolution,  
26 color depth, update rate, pixel rate, color depth, and other image characteristics. The  
27 channels need not be identical, and certain channels may have, for example, different  
28 optimization characteristics or bandwidth than other channels. Channels with certain  
29 characteristics, such as real time capability, or high resolution, could be reserved for  
30 remote sites having a higher priority level.

31 The channels can be digital channels, in which the channel characteristics vary.  
32 Alternatively, the channels can be hard wired. If digital channels, or other variable

1 channels are used, the characteristics of a channel can be altered in order to  
2 accommodate certain remote sites 40, or to accommodate the assignment of additional  
3 remote sites 40 to a channel.

4 Rather than denying access to the image access system 10 due to a lack of  
5 channel availability, the access control 24 can also reconfigure the transmission  
6 characteristics of one or more remote sites 40 so that the image access system 10 can  
7 accommodate more remote sites 40.

8 In step S28, the image access system 10 generates the subimage for transmission  
9 to the remote site 40. The process of generating a subimage is discussed in detail with  
10 reference to Fig. 5. Once the subimage has been generated in step S28, the image access  
11 system 10 transmits the subimage to the remote site 40 in step S30. The remote site 40  
12 displays the subimage in step S32.

13 The return arrow from step S32 to step S28 indicates that frames of the selected  
14 subimage may be continuously generated and transmitted to the remote site 40. If the  
15 subimage is a static image, the image processing system 16 may not refresh the  
16 subimage, and the image displayed at the remote site 40 would not change.

17 If the user at the remote site 40 wishes to view a different subimage, he may  
18 select a different subimage at any time. If the user selects a new subimage, the sensor  
19 control 18 obtains image data from a different portion of the sensed image when  
20 generating the subimage in step S28. The user at the remote site 40 may also change the  
21 transmission characteristics of the subimage at any time, subject to priority level and  
22 channel availability.

23 Referring again to step S24, if there is no channel available for the remote site 40,  
24 the access control 24 asks the remote site 40 whether the access control 24 should wait  
25 for an available channel in step S34. If the user at the remote site 40 decides to wait for  
26 an available channel, the access control 24 periodically monitors the availability of  
27 channels, and assigns a channel to the remote site 40 in step S26 when a channel  
28 becomes available.

29 If the user at the remote site 40 indicates that he does not want to wait for a  
30 channel to become available, in step S36, the access control 24 asks the user whether he  
31 is willing to view subimages currently being transmitted to another remote site 40 that is  
32 assigned a channel. If the user at the remote site 40 does not want to view another

1 user's subimages, he is returned to step S22, where he may select a new subimage,  
2 attempt to select his original subimage choice, or, he may elect to disconnect from the  
3 image access system 10.

4 If the user at the remote site 40 that is not assigned a channel wishes to view  
5 another remote site's subimages, the access control 24 selects a channel that  
6 approximates the user's original subimage selection in step S38. For example, the access  
7 control 24 can include a routine to match the user's preference for a region of the sensed  
8 image, and transmission characteristics, to a subimage currently being transmitted on a  
9 channel assigned to another remote site 40. The remote site 40 is then "assigned" this  
10 channel in a limited capacity in step S26. The remote site 40 sharing another site's  
11 channel is limited in that it may only observe the subimages transmitted on the channel,  
12 and may not alter the subimage.

13 The access control 24 instructs the processor 22 to transmit the subimages to the  
14 remote site in step S30. The processor 22 can include a number of output ports that  
15 exceeds the number of channels n of the image processing system 16. This allows the  
16 processor 22 to transmit duplicate subimages to users at remote sites 40 who are sharing  
17 the subimages communicated on channels assigned to other remote sites 40.

18 Fig. 5 is a flow chart illustrating in detail the step S28 of generating subimages.  
19 In step S40, in response to the access control 24 transmitting the remote site 40 selection  
20 for a subimage, the image data allocator 34 obtains subimage data from the buffer 32  
21 (Fig. 3) corresponding to the user's subimage selection. The subimage data in the buffer  
22 32 may be in, for example, analog format, and the image data allocator may perform  
23 formatting functions such as, for example, byte serial digital formatting. The image data  
24 allocator 34 then transmits the subimage data on the channel assigned to the remote site  
25 40 to the frame buffer 20.

26 The subimages communicated by the assigned channel are then temporarily  
27 stored in the frame buffer 20 in step S42. The frame buffer 20, may, for example,  
28 perform some formatting functions operations on the subimage data. For example, the  
29 frame buffer 20 could scale and normalize the subimage. The access control 24 can  
30 control the transmission of subimages to the processor 22, or, the frame buffer 20 can  
31 independently control the transmission of subimages to the processor 22.

1 In step S44, the processor 22 formats the subimages transmitted on the assigned  
2 channel for transmission to the I/O device 26. The formatting can include, for example  
3 MPEG encoding functions such as, for example, scaling, compressing, and other tasks  
4 that renders the subimage data appropriate for use by the remote sites 40.

5 The embodiments of a method of and apparatus for providing subimages to  
6 remotes sites discussed above have many practical applications. For example, one  
7 embodiment of the present invention could be employed for medical training. In this  
8 embodiment, a surgeon at a remote site could deploy an image sensor 14 to focus on a  
9 patient during an operation. Other medical personnel, located at remote sites 40, could  
10 connect via the connection medium 30, and could view the operation by accessing the  
11 image access system 10. The medical personnel at the remote sites 40 would not be  
12 restricted to any particular region of the image sensed from the operation, and could  
13 electronically pan and zoom on particular subimages of interest. In this embodiment, the  
14 image sensor 14 could have a relatively narrow field of view, sufficient to view the  
15 surgical procedure.

16 Another embodiment of the present invention could be used to train security or  
17 other law enforcement personnel. For example, trainees at remote sites 40 could view a  
18 sensed image selected by a trainer. The image sensor 14 used to sense the image can  
19 have a wide field of view, so that the sensed image captures a variety of actions. The  
20 trainees may be asked to detect suspicious or unlawful activity, and to select a subimage  
21 to more carefully monitor the activity.

22 The present invention may also be used in the field of astronomy. Given the high  
23 cost of building and operating modern high power telescopes, it is preferable to allow as  
24 many users as possible access to each telescope's gathered images. According to an  
25 embodiment of the present invention, the image sensor 14 could be coupled to the optics  
26 of a telescope at, for example, an observatory. In this application, the image sensor 14  
27 may have a relatively small field of view, sufficient to sense a field of view captured by a  
28 telescope. The image access system 10 could utilize the image sensed by the telescope  
29 as the sensed image, and could allow users at remote sites 40 to view subimages of the  
30 sensed image, thereby maximizing the use of the telescope.

31 The steps of the above embodiments can be implemented with hardware or by  
32 execution of programs, modules or scripts. The programs, modules or scripts can be

1 stored or embodied on one or more computer readable mediums in a variety of formats,  
2 such as source code, object code or executable code, for example. The computer  
3 readable mediums may include, for example, both storage devices and signals.  
4 Exemplary computer readable storage devices include conventional computer system  
5 RAM (random access memory), ROM (read only memory), EPROM (erasable,  
6 programmable ROM), EEPROM (electrically erasable, programmable ROM), and  
7 magnetic or optical disks or tapes. Exemplary computer readable signals, whether  
8 modulated using a carrier or not, are signals that a computer system hosting or running  
9 the described methods can be configured to access, including signals downloaded  
10 through the Internet or other networks.

11 The terms and descriptions used herein are set forth by way of illustration  
12 only and are not meant as limitations. Those skilled in the art will recognize that  
13 many variations are possible within the spirit and scope of the invention as  
14 defined in the following claims, and their equivalents, in which all terms are to be  
15 understood in their broadest possible sense unless otherwise indicated.  
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